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Pre-Participation Physical Exams: Are We Doing Enough?

Steven Jacob Pietrusza
University of North Dakota

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Steve Pietrusza PA-S
Department of Physician Assistant Studies, University of North Dakota School of Medicine & Health Sciences
Grand Forks, ND 58202-9037

Abstract

- Inclusion of screening electrocardiograms (EKGs) during pre-participation physical examination has been a topic of debate for some time. There is unquestioned usefulness in the ability of a well-trained health care provider in using EKG to identify cardiac abnormalities.
- Further, there have been several contemporary EKG criteria published that increase specificity and sensitivity of detection of disease. However, these criteria do not account for athletes less than 14 years of age, and that demographic represents a large portion of patients seeking pre-participation screenings in the United States.
- The lack of research into pediatric cardiac remodeling secondary to activity, coupled with the significant overlap in normal pediatric EKG findings with adult pathological EKG findings create a difficult position for any health care provider.
- A literature review was performed to determine if screening EKGs are effective both medically and economically in athletes less than 14 years of age.
- Based on the review, the limitations of contemporary EKG criteria, the inability to prove cost effectiveness in the US healthcare model, and the lack of research into activity modulated pediatric cardiac remodeling should reinforce that the ACC/AHA checklist is an appropriate foundation for conducting pre-participation physical examination.

Introduction

- Pre-participation physical examinations are routinely conducted in the United States in an effort to protect young athletes.
- There are numerous estimates regarding the incidence of sudden cardiac death (SCD) in athletes, ranging from one in 40,000 to one in 80,000, and though SCD is a rare occurrence the multifactorial effects on the surrounding community cannot be denied.
- The majority of recommendations surrounding these physicals support gathering a personal and family history of cardiovascular disease as well as a physical examination.

Statement of the Problem

- Many of the underlying pathologies that lead to SCD produce subtle findings on exam and are difficult for even an experienced Primary Care Provider to detect (Finocchiaro et al., 2016).
- Between 2013 and 2023, 170 million high school and college athletes will require pre-participation physical examination. No estimate is available for primary school children.

Research Question

In patients requiring pre-participation physical examination, would EKG be an effective screening tool, both medically and economically, to identify conditions that may cause SCD in athletes younger than 14 years old?

Literature Review

Contemporary EKG interpretation criteria

- The European Society of Cardiology (ESC) released recommendations intended to improve specificity secondary to increasing number of unacceptably high levels of false positive EKGs.
- The ESC recommendations were followed by the Seattle and refined criteria, which further improved sensitivity and reduced the abnormal rate of EKG to 9.6% and 6.6% ($p<0.001$) respectively.

EKG abnormality	ESC recommendations	Seattle Criteria	Refined criteria
Left atrial enlargement	Negative portion of the P wave in lead V1 ≥ 0.1 mV in depth and ≥ 40 ms in duration	Prolonged P wave duration of > 120 ms in lead I or II with negative portion of the P wave ≥ 1 mm in depth and ≥ 40 ms in duration in lead V1	As ESC
Right atrial enlargement	P wave amplitude ≥ 2.5 mm in lead II, III, or aVF	As ESC	As ESC
Left QRS axis deviation	-30 to -90 degrees	As ESC	As ESC
Right QRS axis deviation	> 115 degrees	As ESC	AS ESC
Right ventricular hypertrophy	Sum of R wave in V1 and S wave in V5 or V6 ≥ 10.5 mm	Sum of R wave in V1 and S wave in V5 > 10.5 and right axis deviation > 120 degrees	As ESC
Complete LBBB	QRS ≥ 120 ms, predominantly negative QRS complex in lead V1 (QS or rS), and upright monophasic R wave in leads I and V6	As ESC	As ESC
Complete RBBB	RSR' pattern in anterior precordial leads with QRS duration ≥ 120 ms	Not relevant	As ESC
Intraventricular conduction delay	Any QRS duration > 120 ms including RBBB and LBBB	Any QRS duration ≥ 140 ms or complete LBBB	As ESC
Pathological Q wave	> 4 mm deep in any lead except III, aVR	>3 mm deep or > 40 ms duration in ≥ 2 leads except III and aVR	≥ 40 ms duration or ≥25% of the height of the ensuing R wave
Significant T wave inversion	≥ 2 mm in ≥ 2 adjacent leads (deep) or "minor" in ≥ 2 leads	> 1 mm in depth in ≥ 2 leads V2-V6, II and aVF, or I and aVL (excludes III, aVR, and V1)	As Seattle criteria
ST segment depression	≥ 0.5 mm deep in ≥ 2 leads	As ESC	As ESC
Ventricular pre-excitation	PR interval < 120 ms with or without delta wave	PR interval < 120 ms with delta wave	As Seattle criteria

From "Comparison of Electrocardiographic Criteria for the Detection of Cardiac Abnormalities in Elite Black and White Athletes", by N. Sheikh, M. Papadakis, S. Ghani, A. Zaidi S. Gati, P.E. Adami, F. Carre F. Schnell, M. Wilson, P. Avila, W. McKenna, S. Sharma, 2014, *Circulation, 129*(16), p. 1640. Copyright 2014 American Heart Association Inc. Reprinted with permission.

Economic Impact

- Corrado et al., (2006) reported a marked decline in SCD among athletes after the implementation of Italian law mandating EKG screening.
- Halkin et al. (2012) recognized that the Corrado study failed to address economic impact. They executed a cost-progression model that estimated the cost of screening EKG would reach $69 billion in the US by 2023.
- European studies provide more favorable economic outcomes, reducing cost to approximately $87 dollars per athlete (Dhutia et al., 2016), but the data lacks portability to the US secondary to dissimilar health care models and degree of subsidization.

Current recommendations

- The American Heart Association and the American College of Cardiology recommend a 14 item checklist when executing a pre-participation screening:

14 Element Cardiovascular Screening Checklist for Congenital and Genetic Heart Diseases	
Personal History	
1.	Chest pain/discomfort/tightness/pressure related to exertion
2.	Unexplained syncope/near syncope*
3.	Excessive exertional and unexplained dyspnea/fatigue or palpitations associated with exercise
4.	Prior recognition of a heart murmur
5.	Elevated systemic blood pressure
6.	Prior restriction from participation in sports
7.	Prior testing for the heart, ordered by a physician
Family History	
8.	Premature death (sudden and unexplained, or otherwise) before age 50 attributable to heart disease in ≥ 1 relative
9.	Disability from heart disease in close relative < 50 years of age
10.	Hypertrophic of dilated cardiomyopathy, long QT syndrome, or other ion challenopatihes, Marfan syndrome, or clinically significant arrhythmias, specific knowledge of certain cardiac conditions in family members
Physical Examination	
11.	Heart murmur**
12.	Femoral pulses to exclude aortic coarctation
13.	Physical stigmata of Marfan syndrome
14.	Brachial artery pressure (sitting position, preferably taken in both arms

*Judged not to be of a neurocardiogenic (vasovagal) origin; of particular concern when occurring during or after physical exertion.
**Refers to heart murmurs judged to be organic and unlikely to be innocent; auscultation should be performed with the patient in both the supine and standing positions (or with Valsalva maneuver), specifically to identify murmurs of dynamic left ventricular outflow tract obstruction.

ACC/AHA Release Recommendations for Congenital and Genetic Heart Disease Screenings in Youth (2014). Retrieved from http://www.acc.org/latest-in-cardiology/articles/2014/09/15/14/24/acc-aha-release-recommendations-for-congenital-and-genetic-heart-disease-screenings-in-youth.

Discussion

- None of the contemporary criteria included children less than 14 years of age in their studies, nor were they intended for use by primary care clinicians alone.
- Leger et al. (2016) point out that there is a significant overlap in normal pediatric EKG findings with adult pathological EKG findings, and that no current data exists on the physiologic cardiac modifications related to exercise in children thus making EKG less effective as a screening tool in children than adults.

Applicability to Clinical Practice

- Concerns for the provider when interpreting an athlete's EKG include both missing a dangerous cardiac condition and generating false-positive interpretations that cause needless further investigations, increased economic cost, and potentially unnecessary activity restriction for the athlete (Drezner et al., 2013).
- The ACC/AHA check sheet provides an appropriate foundation for screening. If suspect findings present themselves, specialist referral prior to participation is appropriate.
- Provider-directed risk stratification of proposed activity levels is also appropriate.

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